

the recent *Operculina* and the fossilized *Nummulites*, especially the tubular formation between the chambers, which Joly and Lcymeric demonstrated *before* Dr. Carpenter, as acknowledged by the latter in his book, and about which Dr. Carpenter does not appear to me to have a true conception *yet*, or he would not continue to identify the so-called *Eozoon canadense* with foraminiferous structure. It is a very different thing to describe from the sections and drawings of others and to argue from a knowledge which you have worked out for yourself. The latter requires an amount of time which is quite incompatible with the former, where quantity is the grand object.

I cannot help adding, in conclusion, my astonishment that while blame has been imputed to me from not having burdened my argument against the so-called "foraminiferous structure of *Eozoon canadense*" by the insertion of detail which I had given elsewhere, my able critics should have foregone the opportunity of expressing their opinion on the grand question of my argument for the purpose of delivering themselves on a point in it of the most trivial consequence. That they should have commenced the second paragraph of their letter with, "The question has nothing to do with the *Eozoon* controversy," is therefore, to say the least of it, "most significant"!

XX.—*On the Invertebrate Marine Fauna and Fishes of St. Andrews.* By W. C. M'INTOSH.

[Continued from p. 75.]

Class ANNELIDA.

The marine annelids have sometimes been considered an uninviting group, dimly associated with parasites and earthworms. In regard, however, to beauty of form and colour, wonderful structure and habits, they are not surpassed by any invertebrate class. The splendid bristles of the Aphroditidæ, constantly glistening with all the hues of a permanent rainbow, the brilliant colours of the Phyllodocidæ, Hesionidæ, and Nereidæ, and the gorgeous branchial plumes of the Terebellidæ, the Sabelidæ, and the Serpulidæ can only be compared with the most beautiful types of butterflies and birds. The structures formed by many exhibit an amount of precision and skill equal to that of the most remarkable insects. Thus, at St. Andrews, the common *Pectinaria belgica* fashions a tube like a straight horn of minute pebbles, carefully selected and admirably fixed

to each other by a whitish cement. In the placing of these together there is no haphazard, but angle fits angle as in a skilfully built wall, and no profusion of the whitish cement hides slovenly masonry. There is much similarity in the ordinary tubes; dozens may be examined without observing any noteworthy structural difference. All have the same blending of the white or light-coloured grains with the yellow, the brown, and the black. There is no chance grouping, so as to cause the tube to be out of harmony with its surroundings; but the whole tone is such that it can with difficulty be distinguished from the sand. Some annelids, again, secrete transparent tubes of the aspect and toughness of crow-quills; while others cement the mud into caoutchouc-like pipes, fix gravel, stones, and shells by the same means into convenient tunnels, or rely on the parchment-like tenacity of a tube formed solely of one or more layers of their remarkable secretion. The interest in the group is further heightened by the brilliant phosphorescence characteristic of many, and the powers which others have of perforating sand, limestone, shells, aluminous shale, sandstone, and other rocks.

The annelids are not devoid of interest even in an economical point of view. All round the coasts of Britain the *Arenicola marina* (common lobworm) is generally used as bait, and here and there *Nephtys* and *Nereilepas fucata*. On the prolific shores of the Channel Islands the great abundance of the Nereidæ is of considerable importance to the inhabitants, since two of the most plentiful (viz. *Nereis cultrifera*, Grube, and *N. diversicolor*, Müller) are extensively used in fishing. The fishermen constantly search for them with a pointed instrument resembling a spear (see annexed woodcut), and keep them in vessels amongst a little sand and seaweed. They are much employed in catching whiting, the latter, again, being used as bait in conger-fishing. In the same islands one of the most esteemed baits is the large *Marphysa sanguinea*, which reaches the length of two feet. It is termed "varme" by the fishermen, and is highly prized both for the capture of ordinary white fish and dog-fish. The annelids are kept alive in vessels amongst seaweed—or rather the anterior segments only, no more than three or four inches of this region being retained, since experience has shown that, unless so treated, the animals will break off posterior fragments, which, putrefying, soon cause the death



of the whole. The natives of the Fiji group much esteem a form allied to the British *Lysidice ninetta* as an article of diet, and they predict its annual appearance in their seas with unerring precision by observing the phases of the moon, as at Samoa. It is called "Palolo" by the Samoans and Tongese, and "Mbalolo," Dr. Denis Macdonald informs us\*, by the Fijians. This annelid occurs in numbers so vast that it is collected by the natives as a dainty and nutritious food; and it is so much prized that formal presents of it are often sent considerable distances from certain chiefs to others, whose small dominions do not happen to be visited by the Palolo. Dr. Macdonald thinks the tendency to transverse fission exhibited by the annelids (since they are seldom got entire) may be connected with the diffusion of the ova, and not with the development of new forms—a conclusion the more likely though by no means necessary. He states that the species had been supposed to exhibit an alliance with *Arenicola*, but that the anatomical characters refer it to the Nereidæ. As already mentioned, it ought rather to be classed with the Eunicidæ. If the Palolo has similar habits to the *Lysidice* of our southern coasts (that is, dwells in fissures and crevices of the rocks at and near low water), it probably leaves its retreats for the purpose of depositing ova. Lastly, *Echiurus* is used as bait by the Belgian fishermen; and a *Sipunculus* is employed as food by the Chinese, whose varied taste ranges from trepangs to edible birds' nests.

If the uses of the majority of the annelids are restricted in the case of man, a very different condition holds with regard to marine animals. An examination of the stomachs of our most valuable fishes shows how acceptable and important a part they play in the supply of nutriment. The large number of species which a few hours' fishing on a rich coast will produce with bait of *Nereis cultrifera* is strongly corroborative; indeed I should be inclined to place them even before crabs and mollusks in respect of the avidity with which fishes devour them. The majority of the annelids of St. Andrews are found in the stomachs of cod, haddock, whiting, flounders, and other common fishes; and it is often puzzling to explain how those which dwell in tubes under stones, in fissures of rocks, and in other remote places have been obtained. To give a satisfactory account of the food furnished by this class to fishes would require an enumeration of every family, and most of the genera and species, found in this country; indeed, I do not know a single form that would be rejected. It will suffice, on the present occasion, to notice a

\* Linn. Trans. vol. xxii. p. 237 (1859).

few of the more conspicuous at St. Andrews. The stomachs of cod and haddock are frequently filled with sea-mice and Polynoidæ; and another very common form is *Sigalion Mathilde*. The Nereidæ (from the gigantic *Alitta virens*, Sars, which often distends the stomachs of large cod, to the smaller *Nereis pelagica* and *N. cultrifera*) are universally eaten. The somewhat uninviting *Trophonia plumosa* sometimes forms the sole food in the stomachs of large haddocks, many hundreds occurring in a single fish. *Owenia filiformis*, with its gravelly tubes, is a favourite diet of the same fish and of cod and flounders. The Terebellidæ and their sandy tubes are also largely devoured; and even Serpulidæ are not passed by. Moreover, in their young or larval forms they constitute an important element in the food of the herring and other fishes that feed near the surface of the water.

Many of the annelids of St. Andrews are common to the whole British area; but some have not yet been found in other parts of our seas: as this, however, is probably due to a larger amount of attention having been directed to the locality, we shall not at present particularize.

The fauna at St. Andrews is distinguished, as far as our present knowledge extends, from the Zetlandic by the absence of such striking forms as *Lætmonice*, *Panthalis*, *Nothria conchylega*, *Terebella nebulosa*, *Pista cristata*, *Trichobranchus glacialis*, and *Ditrypa arietina*; from that of the western regions by the absence of *Spinther*, *Lepidonotus clava*, *Polynoë scolopendrina*, *Ophiodromus vittatus*, *Nereis Dumerilii*, *Gattiola spectabilis*, *Terebella nebulosa*, and *Pista cristata*; and of the southern types we miss *Euphrosyne*, *Hermione*, *Polynoë areolata*, *Nereis Marionii*, *Lysidice ninetta*, the Eunicidæ, the abundance of the Chætopteridæ, *Sabellaria alveolata*, *Lepræa tetrica*, *Sabella saxicava*, *Protula*, and *Filigrana* between tide-marks. The great preponderance of *Polynoë floccosa* in the south is also an interesting feature.

Amongst the annelids that, besides other very common forms, abound at St. Andrews, and therefore most characteristic of it, are *Sigalion Mathilde*, *Sthenelais limicola*, *Phyllodoce laminosa*, *P. grælandica*, *Nereis cultrifera*, *Alitta virens*, *Autolytus pictus*, *Aricia Cuvieri*, *Ophelia limacina*, *Trophonia plumosa*, *Nerine foliosa*, *Polydora ciliata*, *Capitella capitata*, *Sabellaria spinulosa*, *Pectinaria belgica*, *Lanice conchilega*, *Sabella pavonia*, and *Branchiomma vesiculosum*.

Some of the phosphorescent forms at St. Andrews have already been noticed \*; so that in the mean time the remarks

\* Ann. & Mag. Nat. Hist. 4th ser. 1872, vol. ix. pp. 6 & 7.

shall be confined to the Polynoidæ, three common species of which afford ready means of experiment. In *Harmothoë imbricata* irritation causes a series of bluish-green flashes at the points of attachment of the scales, and then a steady light for some time. Very pale specimens seem more irritable than ordinary forms. No pulsations of light are observed on the phosphorescent surface of the detached scales. On the whole the light in this species is characterized by its steadiness. It does not readily emit its phosphorescence when a little sulphuric ether is added to the water; nor does mechanical irritation in these circumstances cause any change in its manifestation. Acetic acid acts as a poison, causing a momentary gleam as the scales are thrown off, which wholly disappears with the death of the animal and the ejection of the proboscis. If strong methylated spirit be gradually added to the seawater (in a small vessel), there is seldom phosphorescence if no mechanical irritation occurs; the animal perishes with all the scales on its back. The luminous emissions are similar when spirit is applied to the annelid in the air. *Polynöë floccosa* seems to be more irritable, and to emit its phosphorescence more readily than the foregoing at the same points. When one of the scales is detached, the greenish light is given off as if in pulsations from the surface of attachment, somewhat quickly at first, then slower, and finally disappearing. In *Evarne impar*, again, the detached scales give off a flashing light, such as might be caused by a swift series of waves, and which quite differs in character from that in *P. floccosa*.

The Gephyreans are not so abundant as on the muddy flats of the west and south, where swarms of the common forms are found in a single spadeful. The highly characteristic *Echiurus vulgaris*, however, occurs, often in great numbers; and though *Priapulidus caudatus* is not met with in the littoral region, nor so large as in the Hebrides, still it is not rare in deep water, and is frequent in the stomachs of fishes.

The Nemerteans, again, are especially abundant between tide-marks, though some range thence to deep water, and a few occur only in the latter. *Amphiporus lactifloreus* is common under stones, and *Lineus gesserensis* and *Cephalothrix linearis* in still greater numbers, especially in muddy places. The great *Lineus marinus* is frequently found under stones, and occasionally in the pools. Near low water the *Tetrastemma* (such as *T. melanocephala*, *T. candida*, *T. vermicula*, *T. flavida*, and occasionally *T. dorsalis*) occur in varying numbers, the latter, however, attaining its maximum amongst the red seaweeds in the laminarian region. By splitting the rocks at fissures *Nemertes Neesii*, *Lineus bilineatus*, *Micrura fasciolata*,

*M. purpurea*, and *Carinella annulata* are found in great beauty; while the intricacies in the roots of the tangles afford favourite sites for *Nemertes gracilis* and others already mentioned. The débris in the fishing-boats is especially productive of fine examples of *Amphiporus pulcher* and *Micrura fusca*\*, both, besides the ordinary method of progression, swimming gracefully through the water like freshwater leeches, by throwing themselves on edge and striking right and left alternately with their flattened tails. The curious *Nemertes carcinophila* is abundant on the ovigerous abdominal hairs of the females of the shore-crab.

Almost all the Nemerteans live well in confinement; and while the development of several is known, that of others (such as *Nemertes Neesii*, *N. gracilis*, *Lineus marinus*, *L. sanguineus*, the *Micrura*, and *Carinella annulata*) affords a fine field for further research. The Nemerteans approach the Annelids proper very closely.

The Rhabdocæla are generally minute, but tolerably numerous amongst the red ascidians hanging from cavern-roofs, or algous and zoophytic growths on the under surface of stones, in tidal pools and near low-water mark.

The Planarians are fairly represented, the common forms frequently occurring under stones between tide-marks, and gliding over the surface of rock or glass like a living skin, which requires a keen eye for detection. When much disturbed they swim a short distance through the water, with a horizontal stroke that has been compared by some to the motion of a skate<sup>†</sup>; but the undulation in the former is much greater than in the latter, which has a gliding or skimming character. They also progress on the surface of the water. Even more active and irritable than the Nemerteans, they move with ease and swiftness—never avoiding any small obstacle, but spreading their thin mobile bodies over it, and continuing their course uninterruptedly. Occasionally when a projecting point is attained, the anterior part of the body is elevated and waved to and fro till a convenient branch of seaweed or zoophyte is reached. Some are very prettily coloured; and though the large and gaudily striped *Eurylepta vittata*, so characteristic of our southern shores, is not found, yet the pink and yellow hues of *Planaria ellipsis* are scarcely less attractive. The little *Planaria ulvæ*, which abounds in the brackish waters of many of the creeks on the western coasts, is absent. The

\* A fine specimen of the large *Cerebratulus angulatus*, O. F. Müller, was sent me from the neighbouring Bay of Montrose by Dr. Howden; but unfortunately no proboscis was present. The two forms closely approach each other.

common *Leptoplana flexilis* may be kept for months in confinement, though it is perhaps less hardy in this respect than the Nemerteans. Even though it perishes, however, it frequently deposits pale brownish masses of agglutinated ova on the side of the vessel; and the development of these can easily be followed.

### Subclass TURBELLARIA.

#### A. APROCTA, Max Schultze.

##### Order I. DENDROCÆLA.

##### Fam. Leptoplanidæ.

##### Genus LEPTOPLANA, Ehrenberg.

*Leptoplana subauriculata*, Johnston, Catalogue of the Non-parasitical Worms, Brit. Mus. p. 6.

Common between tide-marks.

*Leptoplana flexilis*, Dalyell; Johnst. Cat. p. 6.

Abundant under stones between tide-marks.

*Leptoplana atomata*, Müller; Johnst. Cat. p. 6.

Common in the same localities.

*Leptoplana ellipsis*, Dalyell; Johnst. Cat. p. 7.

Not uncommon between tide-marks.

##### Order II. RHABDOCÆLA.

##### Fam. 1. Proboscidea, J. V. Carus.

##### Genus PROSTOMUM, CErst.

*Prostomum lineare*, CErst.; Johnst. Cat. p. 62.

Occasionally found on stones brought from the rocks near low water.

A curious form, having a pointed snout with a globular process posteriorly, and a dull pinkish alimentary canal, was procured from the fishing-boats; but unfortunately I possess only the drawing, upon which, however, every reliance can be placed.

Fam. 2. Schizostomea, O. Schm.

Genus CONVOLUTA, CErst.

*Convoluta paradoxa*, Abildgaard; Johnst. Cat. p. 16.

Very common amongst seaweeds and *Corallina* in tide-pools.

*Convoluta Diesingii*, Schmidt(?), Sitzungsber. der k. Akad. 1852.

Occasionally under stones in rock-pools.

Fam. 3. Mesostomea, O. Schm.

Genus MESOSTOMUM (Dugès), M. Sch.

*Mesostomum bifidum*, n. sp.

On the under surface of stones from low-water mark, East Rocks. One tenth of an inch long, and of a very pretty pale orange hue. The body is pointed anteriorly, dilates in the middle, and diminishes posteriorly, terminating in two processes which have a few rather large papillæ on their crenated edge; these papillæ seem to have a slight sucker-action. There are two semilunar eyes, with the concavity external. The cilia are specially distinct a little behind the snout, on each side, at points corresponding to the long ciliary whips of the developing Nemertean. The male organ formed a spirally marked conical process behind the large median sucker; and the testes were loaded with spermatozoa in various stages of development.

Fam. 4. Derostomea, CErst.

Genus VORTEX, Ehrenberg.

*Vortex capitata*, CErst. Entwurf Plattwürmer, p. 65,  
pl. 1. f. 7.

Occasionally under stones between tide-marks. Many diatoms occur in the digestive canal.

Fam. 5. Opisthometea, O. Schm.

Genus MONOCELIS, Ehrb.

*Monocelis unipunctata* (Fab.), CErst. Ent. Plattw. p. 56.

This appears to be the *Planaria flustræ* of Dalyell. It is abundant under stones between tide-marks.



*Monocelis rutilans*, O. F. Müller, Zool. Danic. iii. p. 49,  
tab. 109. f. 10 & 11.

Occasionally in the laminarian region.

Order NEMERTINEA.

Suborder ENOPLA.

Proboscis furnished with stylets.

Fam. 1. Amphiporidae.

Subfamily AMPHIPORINÆ.

Proboscis proportionally large.

Genus 1. AMPHIPORUS, Ehrenberg.

*Amphiporus lactifloreus*, Johnst. M'Intosh, Brit. Annel.  
(Ray Society), i. p. 156, pl. 1. f. 1 & 2.

Common under stones between tide-marks.

*Amphiporus pulcher* (O. F. Müller), Johnst. *Op. cit.* p. 158,  
pl. 1. f. 3.

Frequent in the coralline ground in crevices of shells. A very large, though fragmentary, specimen appears to be this species. It was found on the West Sands after a severe storm in March. The proboscis is extruded, and the tip of the snout forms a kind of button, which, however, may be due to the condition of the parts; the œsophageal region protrudes as a rugose disk on the ventral surface near the tip. A reddish line along the body is peculiar, and is probably the nerve-cord, since no vivid colouring has been seen in the vessels of ordinary specimens. The dull greyish coloration of the body is also peculiar, and may be partly owing to the brownish-red ova shining through the other tissues, or to alimentary material. The posterior end of the specimen shows the pinkish elements of the digestive chamber and ova.

Genus 2. TETRASTEMMA, Ehrenberg.

*Tetраstemma melanocephala*, Johnst. *Op. cit.* p. 165, pl. 2. f. 1.

Not rare amongst the roots of seaweeds on stones near low-water mark.

*Tetrastemma candida*, O. F. Müller. *Op. cit.* p. 167,  
pl. 2. f. 2 & 3.

Abundant amongst seaweeds on stones in the same localities.

*Tetrastemma vermicula*, De Quatrefages. *Op. cit.* p. 169,  
pl. 3. f. 3.

Common amongst the roots of seaweeds on stones between tide-marks.

*Tetrastemma flavida*, Ehrenberg. *Op. cit.* p. 170, pl. 4. f. 1.

Not uncommon in the same situations.

*Tetrastemma dorsalis*, Abildgaard. *Op. cit.* p. 172, pl. 1. f. 4,  
& pl. 3. f. 4.

In swarms on *Ceramium* and other seaweeds in the laminarian region, and occasionally under stones near low-water mark.

#### Subfamily NEMERTINÆ.

Proboscis proportionally small.

#### Genus 4. NEMERTES, Cuvier.

*Nemertes gracilis*, Johnst. *Op. cit.* p. 176, pl. 2. f. 5.

Frequent under tangle-roots at low water, and occasionally under stones between tide-marks.

*Nemertes Neesii*, Erst. *Op. cit.* p. 178, pl. 3. f. 6,  
& pl. 7. f. 6.

Common in the same localities, in fissures of the rocks between tide-marks, and often from deep water.

*Nemertes carcinophila*, Kölliker. *Op. cit.* p. 180, pl. 1. f. 5.

Very frequent on the abdominal hairs of female *Carcini*.

#### Genus 5. LINEUS, Sowerby.

*Lineus marinus*, Montagu. *Op. cit.* p. 181, pl. 9.

Common between tide-marks and in deep water.

*Lineus gesserensis*, O. F. Müller. *Op. cit.* p. 185, pl. 4. f. 2,  
& pl. 5. f. 1.

Abundant between tide-marks. Green and red varieties are equally common.

*Lineus sanguineus*, Jens Rathke. *Op. cit.* p. 188, pl. 5. f. 2.  
Somewhat less common than the former, in the same sites.

*Lineus bilineatus*, Delle Chiaje. *Op. cit.* p. 191, pl. 6. f. 1.  
Not uncommon between tide-marks, and in deep water.

Genus 8. MICRURA, Ehrenberg.

*Micrura fusca*, M'Intosh. *Op. cit.* p. 196, pl. 6. f. 3.  
Common in the coralline ground amongst old shells.

*Micrura fasciolata*, Ehrenberg. *Op. cit.* p. 197, pl. 6. f. 2.

Not rare in fissures of the rocks between tide-marks, and occasionally from deep water. The uniformly tinted variety frequents the latter.

*Micrura purpurea*, Dalyell. *Op. cit.* p. 200, pl. 7. f. 3.  
Occasionally in the same localities.

Fam. 3. Carinellidæ.

Genus 10. CARINELLA, Johnst.

*Carinella annulata*, Montagu. *Op. cit.* p. 203, pl. 7. f. 5,  
& pl. 8.

Common between tide-marks, and in deep water amongst shells.

Fam. 4. Cephalotrichidæ.

Genus 12. CEPHALOTRICH, Erst.

*Cephalotrich linearis*, Jens Rathke. *Op. cit.* p. 208,  
pl. 4. f. 4 & 5.

Abundant under muddy stones between tide-marks.

Subclass CHÆTOGNATHA.

Genus SAGITTA, Slabb.

*Sagitta bipunctata*, Quoy & Gaimard (?), Krohn.

Vast numbers were found on the West Sands, after a severe storm, in January 1867. They were scattered amidst the

foam on the beach along with multitudes of *Pleurobrachia*; and it is curious that very little else was cast ashore at this time. The season is remarkable, as Prof. Busk, who is the author of a most valuable paper\* on the structure and relations of the animal, thought it would chiefly be procured in fine and calm weather in the towing-net. They were recognized by the active movements of their bodies, which glistened all along the beach like needles of glass.

Subclass GEPHYREA.

Fam. **Echiuridea**, J. V. Carus.

Genus **ECHIURUS**, Cuvier.

*Echiurus vulgaris*, Sav.; Baird, Proc. Zool. Soc. 1868, p. 109.

Abundant amongst the débris on the West Sands after storms.

Fam. **Sipunculidea**, J. V. Carus.

Genus **PHASCOLOSOMA**, F. S. Leuck.

*Phascolosoma Harveii*, Forbes; Baird, *loc. cit.* p. 82.

Abundant in the stomachs of cod and haddock.

*Phascolosoma Strombi*, Montagu; Baird, *loc. cit.* p. 86.

Common in deep water in *Dentalium*, *Turritella*, and *Aporrhais*.

*Phascolosoma Johnstonei*, Forbes; Baird, *loc. cit.* p. 95.

Frequent amongst the roots of corallines and seaweeds on stones in pools, and in crevices of rocks. Ranges to deep water in shells.

Fam. **Priapulidea**, J. V. Carus.

Genus **PRIAPULUS**, Lam.

*Priapulus caudatus*, Lam.; Baird, *loc. cit.* p. 104.

Frequent in the stomachs of cod and haddock, and from deep water.

[To be continued.]

\* Journ. of Microscop. Science, 1856, p. 14.